



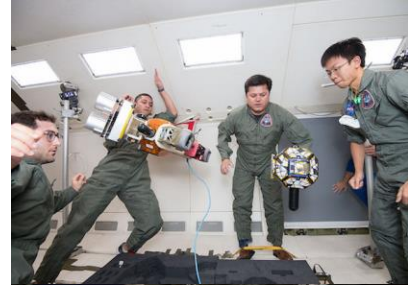
Flight Opportunities

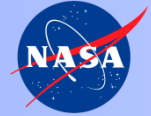
NASA Flight Opportunities Program

ARC Instrument Working Group

Aug 3, 2016

Technology Manager – Stephan Ord

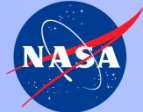




Questions about Flight Opportunities

We'll answer these questions today . . .

- **What is the Flight Opportunities Program?**
- **What suborbital space environments does the program provide?**
- **What makes a payload eligible to fly?**
- **How much money is available for flights?**
- **Why do I need to fly?**



Space Technology Mission Directorate Pipeline

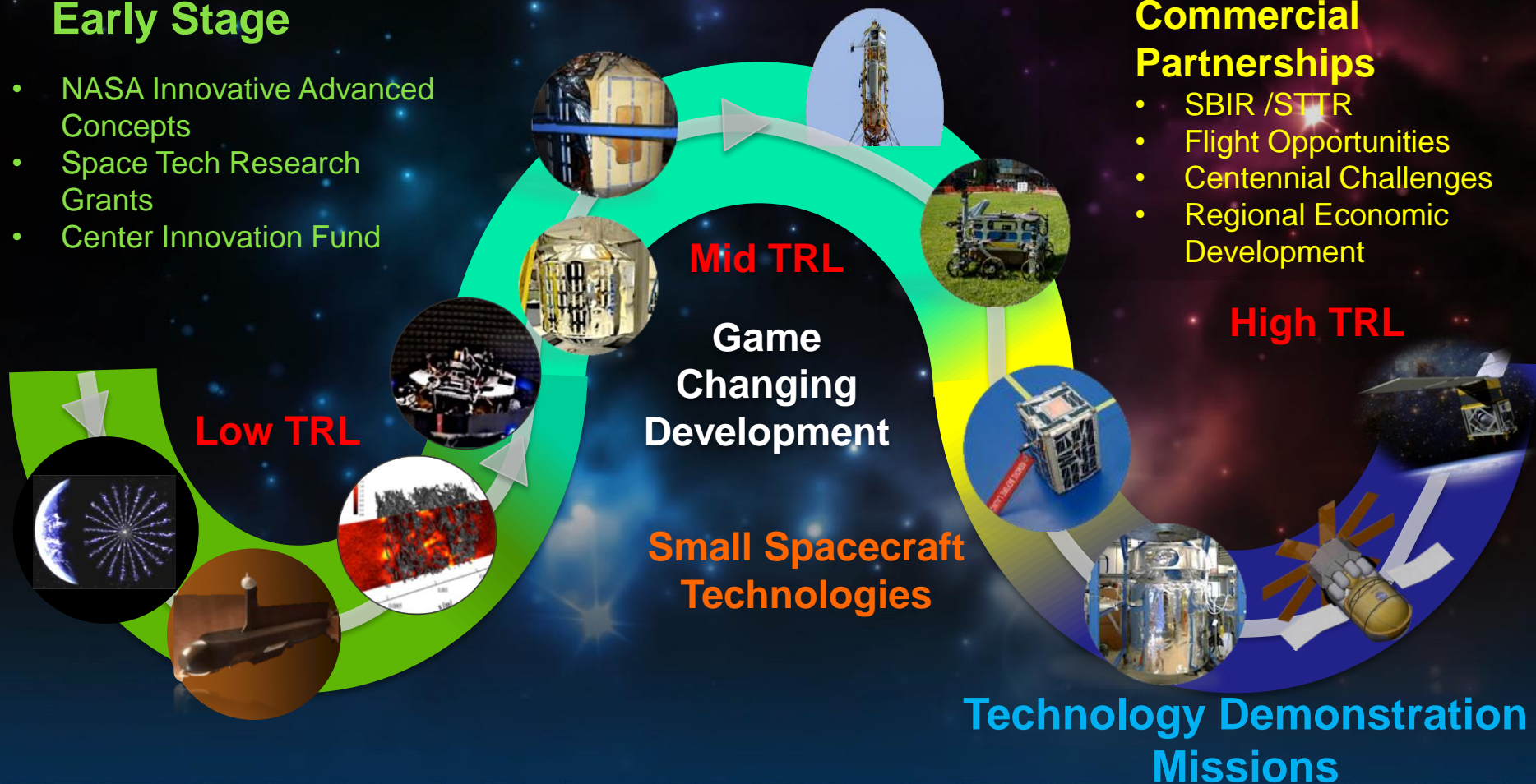
Early Stage

- NASA Innovative Advanced Concepts
- Space Tech Research Grants
- Center Innovation Fund

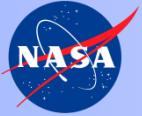
Flight Opportunities

Commercial Partnerships

- SBIR /STTR
- Flight Opportunities
- Centennial Challenges
- Regional Economic Development



TECHNOLOGY PIPELINE

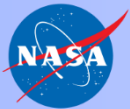


Flight Opportunities Overview

Program facilitates technology development for innovative space technologies to:

- *Reduce risk*
- *Reduce cost*
- *Improve performance*
- *Advance capabilities*





Accessing Flight Opportunities

Multiple paths are available for developing and testing technologies

- **SpaceTech-REDDI Umbrella NRA**

- **Appendix F1 – Tech Advancement Using Suborbital Flight Opportunities**
 - U.S.-based researchers receive funding to purchase proposed flight testing directly from commercial providers
- **Tipping Point Technologies Appendix**
 - Embraces public-private partnerships between NASA and US industry to expand capabilities in space

- **NASA Internal Calls for Payloads**

- U.S. government researchers access flight testing via contracted commercial suborbital flight providers

- **Announcement of Collaborative Opportunity**

- “Sister solicitation” to Tipping Point Appendix
 - Provides opportunities for industry-led effort



Why Should I Fly?

Goal of REDDI NRA Appendix F1 and Internal Call for Payloads

- Demonstrate crosscutting space technologies in relevant space-like environments using currently available U.S. commercial reduced gravity, high-altitude balloon, and suborbital reusable flight capabilities

Flying reduced cost suborbital flights reduces risk!!

Radiation
Effects

Viscous
Effects

Thermal
Effects

Sensor
Response

Deployment
Mechanisms

Fluid
Response

Lander
Control

Typical Flight Profiles

P1 -- Micro-g and/or Space Environment

Experiment requires >2 min of continuous micro-g and/or exposure to space environment

80km minimum
+/- 0.005g for > 2 min
Near-vacuum/Low T – optional

Sounding rocket (UP SL, EXOS SARGE) or spacecraft (Virgin Galactic SS2, Blue Origin New Shepard)

P3 -- Space Environment w/ Free-Fall Descent

Test systems/components such as thermal protection or decelerators for objects reentering planetary atmosphere

80km min, typically ≥ 100 km
Payload ejection at apogee
Followed by rapid free-fall descent of payload to 0 km AGL

Sounding rocket (UP SL) with payload ejected at apogee

P5 – Controlled High Altitude Ascent and Descent

Test remote sensing system for planetary entry, high-altitude atmospheric measurements, or similar applications

30km min
Controlled trajectory ≥ 1 min above 30km
Descend to 0 AGL along controlled trajectory
Access to external environment for observations
Short duration reduced gravity

VG SS2, HASS
Glider dropped from balloon

P2 – High Altitude Exposure

Payload remote sensing package or other system being qualified for satellites/spacecraft

30km min for 1 hour min
Followed by descent to 0 AGL
Descent may test parachutes/atmospheric descent systems

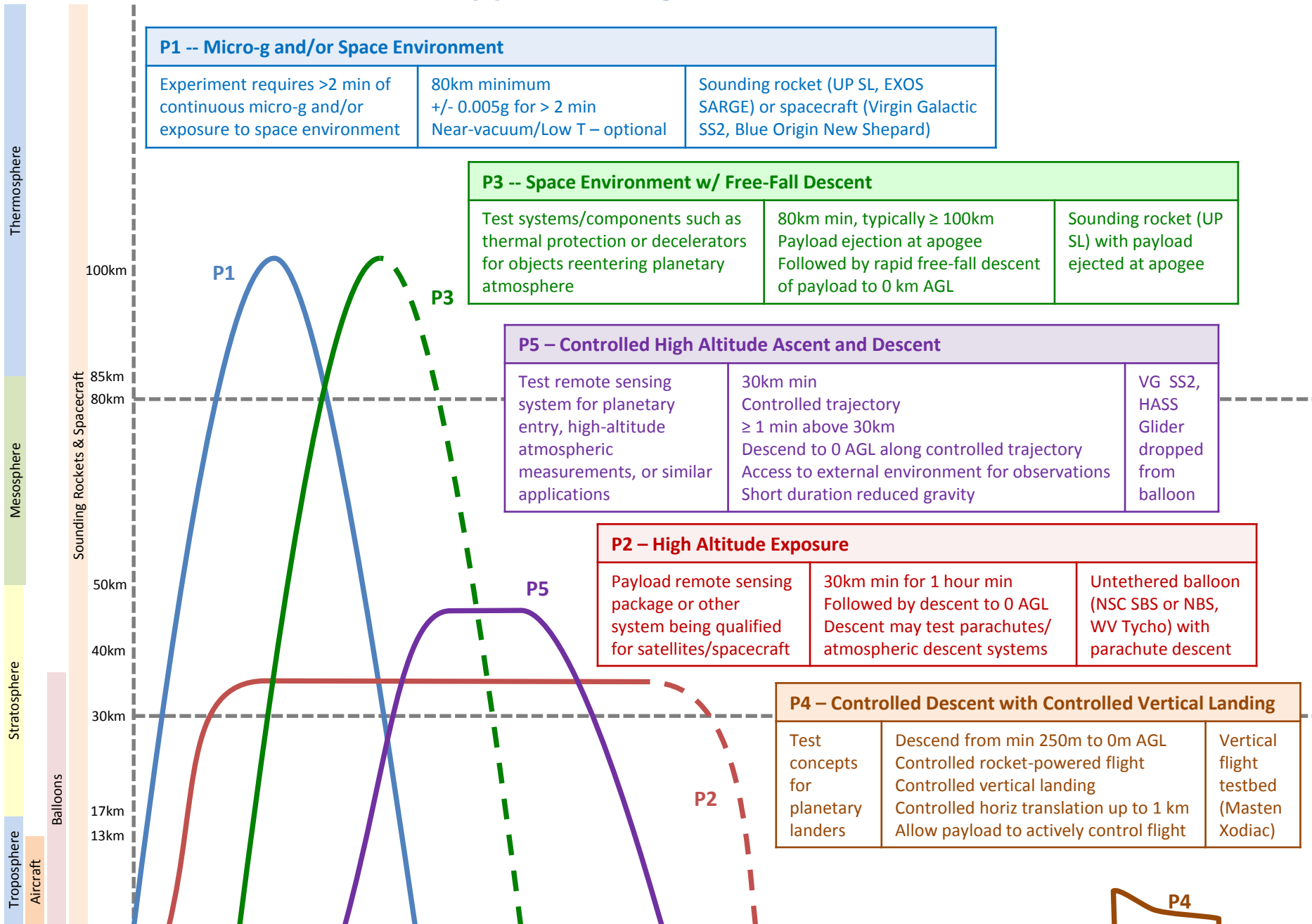
Untethered balloon (NSC SBS or NBS, WV Tycho) with parachute descent

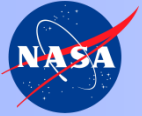
P4 – Controlled Descent with Controlled Vertical Landing

Test concepts for planetary landers

Descend from min 250m to 0m AGL
Controlled rocket-powered flight
Controlled vertical landing
Controlled horiz translation up to 1 km
Allow payload to actively control flight

Vertical flight testbed (Masten Xodiac)





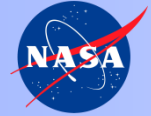
Typical Flight Platforms

Parabolic Flight Vehicle



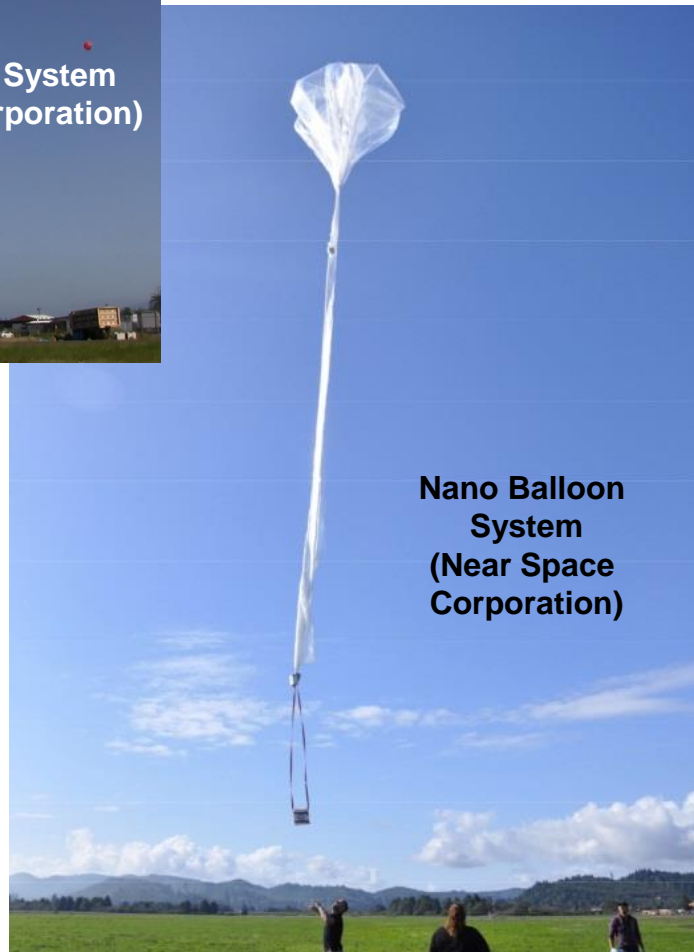
Suborbital Reusable Launch Vehicles (sRLV)

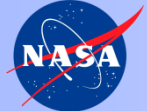




Typical Flight Platforms

High-Altitude Balloons





Flight Opportunities Call/Solicitation Overview

Two Paths for Flying Technologies

External

(Use Any Qualified Flight Vehicle)

**SpaceTech-REDDI NRA
Appendix F1
Solicitation**

Universities

Private Entities (for-profit)

Private Entities (non-profit)

FFRDCs (incl. NASA JPL)

Foreign Entities

w/ Lead U.S. Partner



Internal

(Use IDIQ-2 Contract Flight Vehicles)

NASA Internal Call

STMD Programs

(e.g. GCD, NRA, CIF, SBIR, SST)

Other Mission Directorates

(e.g. ROSES, HOPE, USIP, HERO)

Other Government Agencies

(e.g. FAA)



Call/Solicitation Overview

Eligibility

- TRL 4 at time of submission - hardware should already have been bench tested
- U.S. entities (for-profit & non-profit)
- Foreign entities when in partnership with a U.S. entity – U.S. entity must be lead

Key Dates

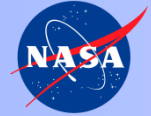
- External Calls (REDDI Appendix F1) – 2 per year
- Internal Calls (NASA Internal Call for Payloads) – 4 per year

REDDI F1 Award Details

- Awards up to \$300K
 - Max \$250K for allowable flight costs (flight costs + indirect costs related to flight cost only)
 - Max \$50K for other costs (indirect costs, travel, labor, materials to build flight hardware)
 - Max amounts include any indirect costs if applicable
 - Researchers contract directly with Flight Providers for flights

NASA Internal Call Award Details

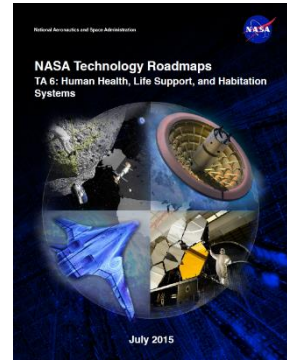
- FO provides flight from flight providers currently on contract with FO
- Max \$50K for other costs (no Civil Service travel or labor)



Call/Solicitation Overview

REDDI Appendix F1 Topics

- **Topic 1: Demonstration of Space Technology Payloads**
 - Technologies that address one or more needs described in Space Technology Roadmaps (STRs), National Research Council (NRC) recommendations, Strategic Space Technology Investment Plan (SSTIP), and STMD focus areas
- **Topic 2: Demonstration of Vehicle Capability Enhancements and Onboard Research Facilities for Payload Accommodation**
 - Demonstration of new or enhanced onboard facilities for commercial suborbital reusable launch vehicles, reduced gravity aircraft, and high altitude balloons that will **improve or enable use vehicles for science research and/or technology flight test applications**



NASA Internal Call for Payloads Applicability

- The NASA Internal Payload request is applicable to NASA internal and funded technology development activities seeking maturation advancement from Technology Readiness Level (TRL) 4.



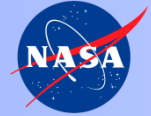
REDDI F1 - Evaluation Criteria Overview

REDDI F1 Evaluation Criteria

- **Criterion 1 - Relevance to U.S. Space Exploration and Utilization (40%)**
 - Alignment
 - Comparison to State of the Art
 - Infusion Potential
- **Criterion 2 - Technical Approach (35%)**
 - TRL Assessment
 - Technology Development Plan
 - Includes degree of support/funding provided to date **by other sponsors**
 - **Demonstrate flight test is required**
 - Flight Test Plan
 - Qualifications and Capabilities
- **Criterion 3 - Cost, Value, and Schedule (25%)**
 - Cost – i.e. test plan makes optimal use of flight(s))
 - Value
 - Technology reduces mission and life-cycle costs, increases safety, or reduces risk, etc.
 - Potential to benefit more than one customer or mission type
 - Extent of cost-sharing provided by proposer
 - Schedule



Important for STMD investment decision



NASA Internal Call - Evaluation Criteria Overview

NASA Internal Call Evaluation Criteria

- **Criterion 1 - NASA Mission Directorate Support**
 - Letters of support from a NASA Mission Directorate
- **Criterion 2 - Relevance to U.S. Space Exploration and Utilization**
 - Alignment with NASA strategic investment plans, Space Technology Roadmaps, Strategic Thrust Areas
- **Criterion 3 – Comparison to State of the Art and Requirement for Flight**
 - Extent that technology is revolutionary, disruptive, transformational
 - Mission enabling capability or substantial improvement relative to state-of-the-art
 - Compelling case for flying payload vs. ground testing
- **Criterion 4 – Past Performance**
 - Initial selection manager input on team's development performance
 - Previous flight test activities



Important Things to Communicate

Technology Need

- Describe current state of the art
- Describe need for improvement
- Describe **how your technology will advance the state of the art**
- What will I now be able to do?

Technology Concept

- Describe your technology – how does your technology work
- If the technical review panels don't understand how your technology works, it's difficult to evaluate

Flight Test Plan

- **REDDI F1** - Make sure that you have worked out the flight test with the flight provider – minimum number of parabolas, minimum altitude, etc.
- **NASA Internal Call** – Identify type of flight required per the call – our campaign managers will eventually work with you to determine the best flight provider

Gecko Grippers

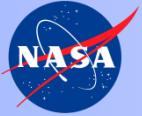
A novel approach to grappling non-cooperative objects in microgravity



	Achievement	Outcome
2014	Parabolic flight test	Demonstrated grappling ability
2015	Parabolic flight test	Demonstrated mobility and free-floating grappling
2016	Deployment to ISS	Longer duration testing in microgravity



Testing helped researchers adjust design and demonstrate functionality in a realistic operational environment



Additive Manufacturing Facility (AMF)

Enabling production of critical components in micro-gravity

MADE IN SPACE

	Achievement	Outcome
2011	Parabolic flight test	Technology optimization for microgravity
2013	SBIR Phase 3	Develop printer for ISS
2013	Parabolic flight test	Demonstrated effectiveness
2014	Deployment to ISS	Zero-Gravity 3D experimental printer operated successfully
2016	Deployment to ISS	AMF deployed as a permanent manufacturing facility on ISS



In-flight observations enabled hardware/software modifications and rapid optimization for operation in microgravity



Flight Opportunities Contact Info

If you would like to get started . . .

Flight Opportunities Contact:

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sord@nasa.gov - email

www.nasa.gov/flightopportunities - NASA FO Website

<https://flightopportunities.nasa.gov/technologies/> - FO Technologies

<http://flightopportunities.nasa.gov/newsletter> - Newsletter Signup